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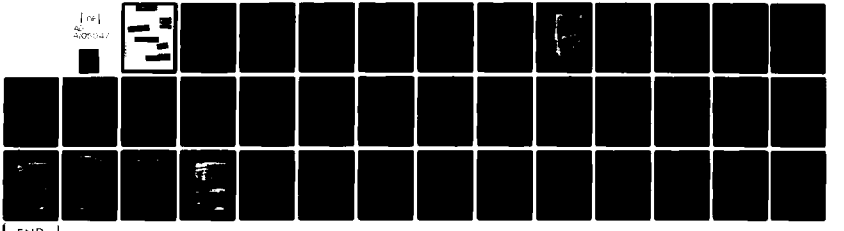

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Peaceful Valley Lake Dam (MO 30196).
Upper Mississippi - Mississippi - Kaskaskia - St. Louis Basin. Gasconade County, Missouri. Phase 1 Inspection Report.

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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Peaceful Valley Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Peaceful Valley Lake Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood
2) Overtopping could result in dam failure.
3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY: SIGNED
Chief, Engineering Division

23 FEB 1979
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

23 FEB 1979
Date

PEACEFUL VALLEY LAKE DAM

GASCONADE COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30196

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY

Kenneth Balk and Associates, Inc.
St. Louis, Missouri

Shannon & Wilson, Inc.
St. Louis, Missouri

PREPARED FOR

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

NOVEMBER, 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Peaceful Valley Lake
State Located	Missouri
County Located	Gasconade County
Stream	Tributary To Cedar Branch Creek
Date of Inspection	August 24, 1978

Peaceful Valley Lake Dam, Mo. No. 30196 was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U. S. Army, Washington, D.C., with the help of Federal and State agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Peaceful Valley Lake Dam was visually inspected by an interdisciplinary team of engineers from Kenneth Balk & Associates, Inc. and Shannon & Wilson, Inc. The purpose of the inspection was to make a preliminary assessment of the general condition of the dam with respect to safety in order to determine if, in the opinion of the interdisciplinary team, the dam poses recognizable hazards to human life or property. This assessment is based solely upon data made available and visual evidence observed during the site visit.

To make a complete assessment of the safety of the dam would require detailed studies and engineering analyses beyond the scope of this preliminary assessment.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The estimated damage zone extends eight miles downstream of the dam. Within the first two and one half miles downstream of the dam are three to five houses and associated farm buildings and two improved roads. Peaceful Valley Lake Dam is in the intermediate size classification since it is greater than 40 feet high but less than 100 feet high.

The inspection and evaluation indicate that the spillway of Peaceful Valley Lake does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Peaceful Valley Lake is an intermediate size dam with a high hazard potential, required by the guidelines to pass the PMF. Considering the high hazard potential to loss of life and property downstream of the dam, the outlet facilities of Peaceful Valley Lake Dam should be able to pass the PMF without overtopping the dam. However, it was determined that the spillway will only pass approximately 10 percent of the PMF without overtopping the dam.

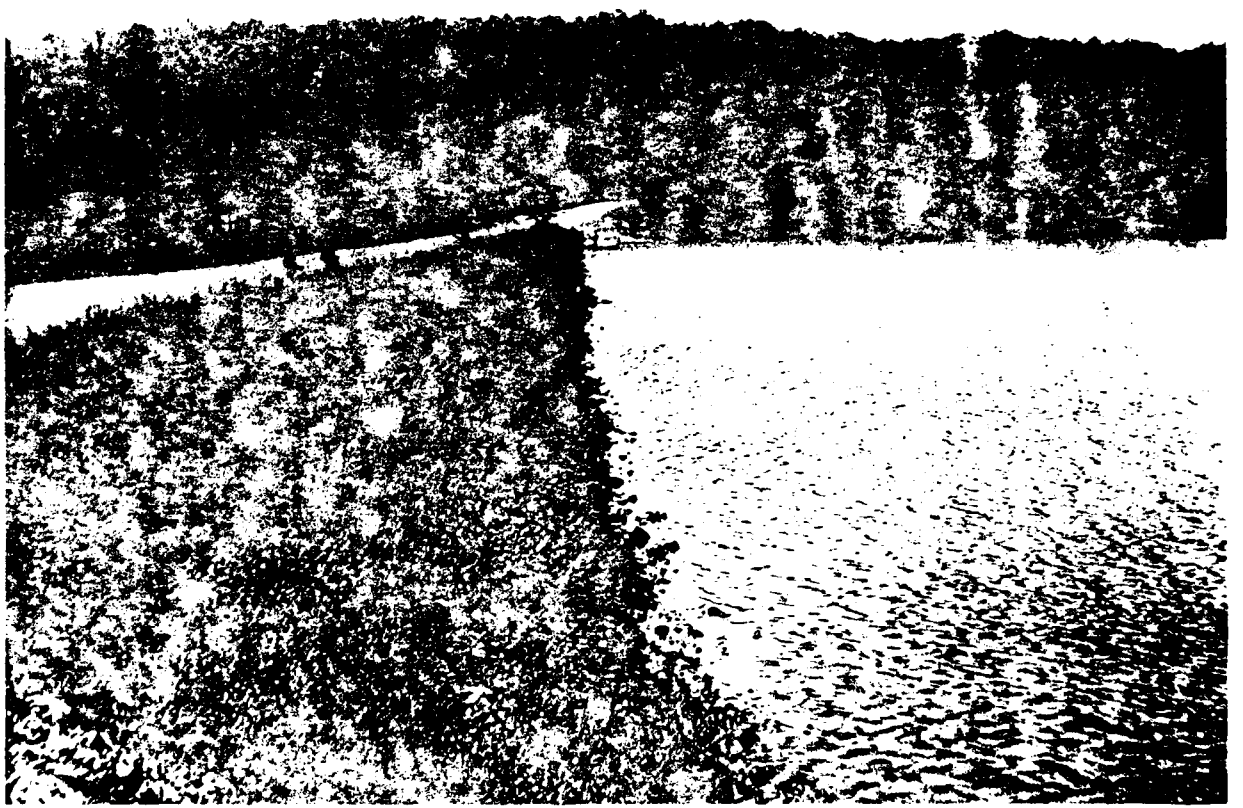
The evaluation of Peaceful Valley Lake also indicated that the spillway will not pass the 100-year flood; that is, a flood having a 1 percent chance of being equalled or exceeded during any given year.

Deficiencies visually observed by the inspection team were seepage, erosion channels on the downstream slope, and thick brush and small trees on the downstream slope of the embankment. Other deficiencies found were the lack of seepage records, operational records, seepage and stability analyses comparable to the requirements of the Recommended Guidelines, and seismic stability analyses.

It is recommended that action be taken in the near future to correct or control the deficiencies described.

Ervin H. Baumeyer, P.E.
Principal-In-Charge
Kenneth Balk and Associates, Inc.
St. Louis, Missouri

Lutz Kunze, P.E.
Principal Engineer
Shannon & Wilson, Inc.
St. Louis, Missouri



Overview of Lake and Dam

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
PEACEFUL VALLEY LAKE DAM - I.D. NO. 30196

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LIST OF PLATES

LIST OF PHOTOGRAPHS

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Peaceful Valley Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon data made available and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure built in a narrow valley in the central part of Gasconade County, Missouri. Topography adjacent to the valley is rolling and is shown on Plate 1.

(2) The spillway with an approach channel and outlet channel is cut in bedrock on the left abutment.

(3) Pertinent physical data are given in Paragraph 1.3 below.

b. Location. The dam is located in the mid southern portion of Gasconade County, Missouri, as shown on Plate 2. The lake formed by the dam is on the Missouri-Gasconade County Bland quadrangle sheet in the NE 1/4 of Section 25, T 42N, R6W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the intermediate size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph c. Based on referenced guidelines, the Corps of Engineers has determined that this dam is in the High Hazard Classification and thus has been selected by the Corps of Engineers for a Phase I inspection.

e. Ownership. It is our understanding that this dam is owned by Peaceful Valley Lake Limited Partnership. 4660 Kenmore Avenue, Suite 1200, Alexandria, Virginia 22304.

f. Purpose of Dam. The dam forms a recreational lake.

g. Design and Construction History: There are no known design plans or construction records. The dam was completed in 1965.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation and spillway discharge all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 3085 acres.

b. Discharge at Damsite.

(1) Spillway 567.4 cfs. at maximum pool.

(2) Estimated experienced maximum flood - approximately two feet below top of dam, with an estimated discharge rate of approximately 182 cfs.

c. Elevation Add three feet to elevations shown to obtain U.S.G.S. elevations.

(1) Top of dam - 774±.

(2) Invert of spillway - 770.

(3) Spillway Crest - 770.

(4) Streambed at Centerline of Dam - 718.0±.

(5) Maximum Tailwater - unknown.

d. Reservoir. Length of maximum pool - 7000 feet ±.

e. Storage (Acre-Feet).

(1) Normal - 4128.

(2) Maximum - 4784.

f. Reservoir Surface (Acres).

(1) Top of dam - 169.4.

(2) Spillway crest - 158.9.

g. Dam.

(1) Type - earth embankment.

(2) Length - 1100 feet.

(3) Height - 60 feet maximum.

(4) Top width - 27 feet.

(5) Side Slopes - (Measured by slope meter/inclinometer in degrees and converted to ratios.)

(a) Downstream - 2.5 H to 1 V.

(b) Upstream - 3 H to 1 V.

(6) Zoning - unknown.

(7) Impervious core - unknown.

(8) Cutoff - unknown.

(9) Grout curtain - unknown.

h. Diversion and Regulating Tunnel. - None

i. Principal Spillway.

(1) Type - Rock channel, flat bottom.

(2) Crest elevation - 770 Add three feet to elevations shown to obtain U.S.G.S. elevations.

(3) Width of bottom - 25 feet.

(4) Average longitudinal slope - 0.96%.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were found to be readily available.

2.2 CONSTRUCTION

The dam was completed in 1965. No construction data was made available.

2.3 OPERATION

No records of the maximum loading on the dam were available.

2.4 EVALUATION

a. Availability. No engineering data were readily available. A geological report by the Missouri Geological Survey was available and was considered in the preparation of this report.

b. Adequacy. No engineering data was available to make a detailed assessment of the design, construction, and operation. The lack of seepage and stability analyses comparable to the requirements of the Recommended Guidelines is considered a deficiency which should be corrected. An engineer experienced in the design of dams should be retained to perform detailed seepage and stability analyses.

c. Validity. No valid engineering data on design were available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General. A visual inspection of the Peaceful Valley Lake Dam was carried out on August 24, 1978. Personnel making the inspection were employees of Kenneth Balk and Associates, Inc. and Shannon and Wilson, Inc. of St. Louis and included civil, geotechnical and structural engineers and an engineering geologist. Specific observations are discussed below.

B. Dam. The inspection team observed the following at the dam.

The dam is a earth structure with a gravel road running the length of the crest. The downstream slope of the dam is densely covered with brush and some small trees. No detrimental settlement, depressions, cracking, animal burrows, or slope instability was observed. However, such features could be present under the dense vegetation and not be visible. Cattails were growing at the junction of left abutment and downstream face approximately half way up the slope and along the toe. The seepage observed was not of sufficient quantity to measure and could be classified as between marshy conditions and perceptible flows. Cattails and standing water was also observed at toe between the embankment and a sewage lagoon existing approximately 70 feet downstream of the dam.

A sanitary sewer extends through the embankment and two manholes were observed on the downstream face of the dam near the right abutment draining to a lagoon downstream from the toe of the dam. The alignment of the sewer pipe judging by the two manholes, is approximately northeast and southwest, however, the origin and pipe size were not known. Several erosion channels two to four feet deep were found along a 50 foot long stretch on the downstream slope of the embankment near the right abutment. Riprap ranging from gravel size to approximately 4 inches, without an apparent filter was observed at the waterline on the upstream face of the dam.

C. Appurtenant Structures. A 25 foot wide and 10 foot deep principal spillway is cut in bedrock on the left abutment. The approach and outlet channel are also of the same width and depth, cut in the rock. The spillway outlet channel has a high bridge crossing it approximately 80 feet downstream of the crest of the dam. No vegetation was observed in any of these structures. A swale is located at the right or south abutment. At its lowest point, the swale is approximately 3.3 feet lower than the crest of the dam. This swale was apparently constructed to provide more convenient access to the boat launching area. In the opinion of the inspection team, this swale was not intended to act as an overflow spillway, since discharge through the swale would to to the left down the back slope of the embankment.

D. Reservoir Area. No wave wash, excessive erosion or slides were observed along the shore of the reservoir.

E. Dam Site Geology. Left Abutment: Exposed on left abutment in the spillway are alternate beds of dolomite, cherty dolomite, argillaceous dolomite and shale, which probably belong to the Canadian series of Ordovician System. In the absence of any marker bed the stratigraphic position of this outcrop is doubtful. The sequence and thickness of the beds, noted from top to bottom is as follows:

Light brown, moderately weathered, highly fractured, medium hard, moderately crystalline, thinly bedded dolomite containing chert. Thickness 2 - 4 feet.

Light brown, medium to fine crystalline, moderately weathered, fractured, dolomite containing some argillaceous material and broken and rotten chert. Thickness 3 - 5 feet.

Brown to light brown in color, medium crystalline, medium hard argillaceous dolomite interbedded with thin light brown argillaceous shale. Thickness 1 foot.

Light gray, hard, moderately to finely crystalline, moderately weathered, dolomite massive in nature. Thickness 2 - 2½ feet.

Dolomite, gray in color, moderately to highly fractured, interbedded with soft brown argillaceous shale. Thickness 1 - 2 feet.

Arenaceous dolomite, gray, medium hard, moderately crystalline interbedded with brown argillaceous shale and chert nodules. Thickness not determined.

Joints: Two sets of joints i.e. horizontal along the bedding and vertical joints have been noted:

Bedding, dip = 11 degrees NNW
Strike = 35 degrees NE
Vertical Joints = Strike 65 degrees NE
Joints Width = 1/8 inches to 1/2 inch
Filling Material - Argillaceous and Calcareous material, at few places silicous material
Joint Spacing = 1 foot to 5 feet
Open Joints - 15%, closed joints = 85%

Faults: A fault, whose extent could not be measured due to the overburden, is exposed on the left face of the spillway. It is a normal fault with a displacement of 1½ feet to 2 feet. This fault has a dip of 57 degrees and strike 32 degrees NNE.

Right Abutment: Except for a small outcrop of white to buff colored medium crystalline, medium hard, arenaceous dolomite containing chert dolomite, the rest of the abutment is covered with a thick blanket of gray to brown colored clayey silt containing angular to subangular pieces of chert and dolomite, ranging in size from ¼ inch to 1½ inches.

3.2 EVALUATION

The dense vegetative cover on the downstream slope of the dam made a thorough visual inspection difficult and several deficiencies, i.e., animal burrows and seepage may be present but not visible. The erosion channels noted constitute a deficiency and together with the seepage observed may adversely affect the stability of the dam. The standing water between the toe of the dam and the sewage lagoon masks any evidence of through-seepage and the water should be drained. All of the above noted deficiencies should be corrected. The riprap on the upstream slope appears adequate for this dam, at the present pool level, however, at higher pool levels the protection may not be adequate.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Peaceful Valley Dam has no controlled outlet works, therefore, no operational procedures exist. The lake level is controlled by rainfall, run off, evaporation and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

The downstream slope of the embankment was covered with dense brush and small trees and based on this amount of vegetation, it is concluded that it has been several years since any maintenance has been performed.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

The dense brush and small trees on the slopes and in the area of the toe should be removed and the water ponding at the toe should be drained. A regular program of vegetation control should be initiated and records kept.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. There were no hydraulic and hydrological design data made available.

b. Experience Data. The drainage area and lake surface area are developed from USGS Bland Mo. Quadrangle, 15 minute series, dated 1932. Subsequent to the inspection date, an advance sheet, 7.5 minute series, of the Bland, SE Mo., East Zone was made available. The drainage area and lake surface area were revised to conform with this sheet. The spillway and dam layout are from surveys made during the inspection.

c. Visual Observations.

(1) The spillway and outlet channel are in good condition. The spillway outlet channel is located at the left or north abutment. Spillway discharges, in our opinion, will not endanger the integrity of the dam.

(2) A swale is located at the right or south abutment. At its lowest point, the swale is approximately 3.3 feet lower than the crest of the dam. This swale was apparently constructed to provide more convenient access to the boat launching area. In the opinion of the inspection team, this swale was not intended to act as an overflow spillway, since discharge through the swale would go to the left down the back slope of the embankment. The low point in this swale was therefore selected as the low point of the top of the dam.

d. Overtopping Potential. The principal and overflow spillways have been found to be inadequate to pass the Probable Maximum Flood (PMF) without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

For the PMF, the dam would be overtopped to a maximum height of approximately 7.5 feet with a duration of overtopping of approximately 13.5 hours with a maximum discharge rate of 30,037 cfs. In our opinion, failure of the dam may be expected to occur as a result of overtopping for this length of time.

For 50% of the PMF, the dam would be overtopped to a maximum height of approximately 5.5 feet, for a duration of approximately 10.8 hours with a maximum discharge rate of approximately 16.5 hours.

The spillways have been found to be adequate to pass a flood of approximately ten percent (10%) of the PMF.

The spillway has been found to be also inadequate to pass the 100-year flood, which has a 1% chance of being equalled or exceeded at least once during any given year.

The estimated damage zone extends eight miles downstream of the dam. Within the first two and one half miles downstream of the dam are three to five houses and associated farm buildings and two improved roads.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visually observed conditions which can affect the structural stability of this dam have been discussed in Section 3.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam were found except that discussed in Section 1.2.

c. Operating Records. No appurtenant structures requiring operation exist at the dam, therefore no records were available.

d. Post-Construction Changes. No post-construction changes are known or apparent.

e. Seismic Stability. Peaceful Valley Lake Dam is located in Seismic Zone 1. No engineering data was available to evaluate the seismic stability, however to our knowledge, an earthquake of the magnitude that may be expected in Seismic Zone 1 has not caused a structural collapse of a dam of this size and magnitude.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Corrective measures should be taken for the deficiencies visually observed by the inspection team, i.e. seepage, erosion, and growth of brush and small trees on the embankment. Inadequate spillway capacity is also considered to be a deficiency which should be corrected.

b. Adequacy of Information. No engineering design and construction data was available and the conclusions of this report are based on performance and external visual conditions. A geologic report by the Missouri Geological Survey was available, and was considered in the preparation of this report. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analysis comparable to the requirements of the recommended guidelines (including seismic analyses) were not available and this is considered a deficiency which should be rectified.

7.2 REMEDIAL MEASURES

a. O&M Procedures. The following O&M procedures are recommended:

(1) Trees and excessive vegetation should be removed from the downstream slope.

(2) Seepage should be monitored to determine the quantity of flow and sedimentation and it is recommended that corrective measures be designed by an experienced professional engineer based on appropriate analyses.

(3) Erosion channels should be filled and a grass cover planted to prevent recurrence.

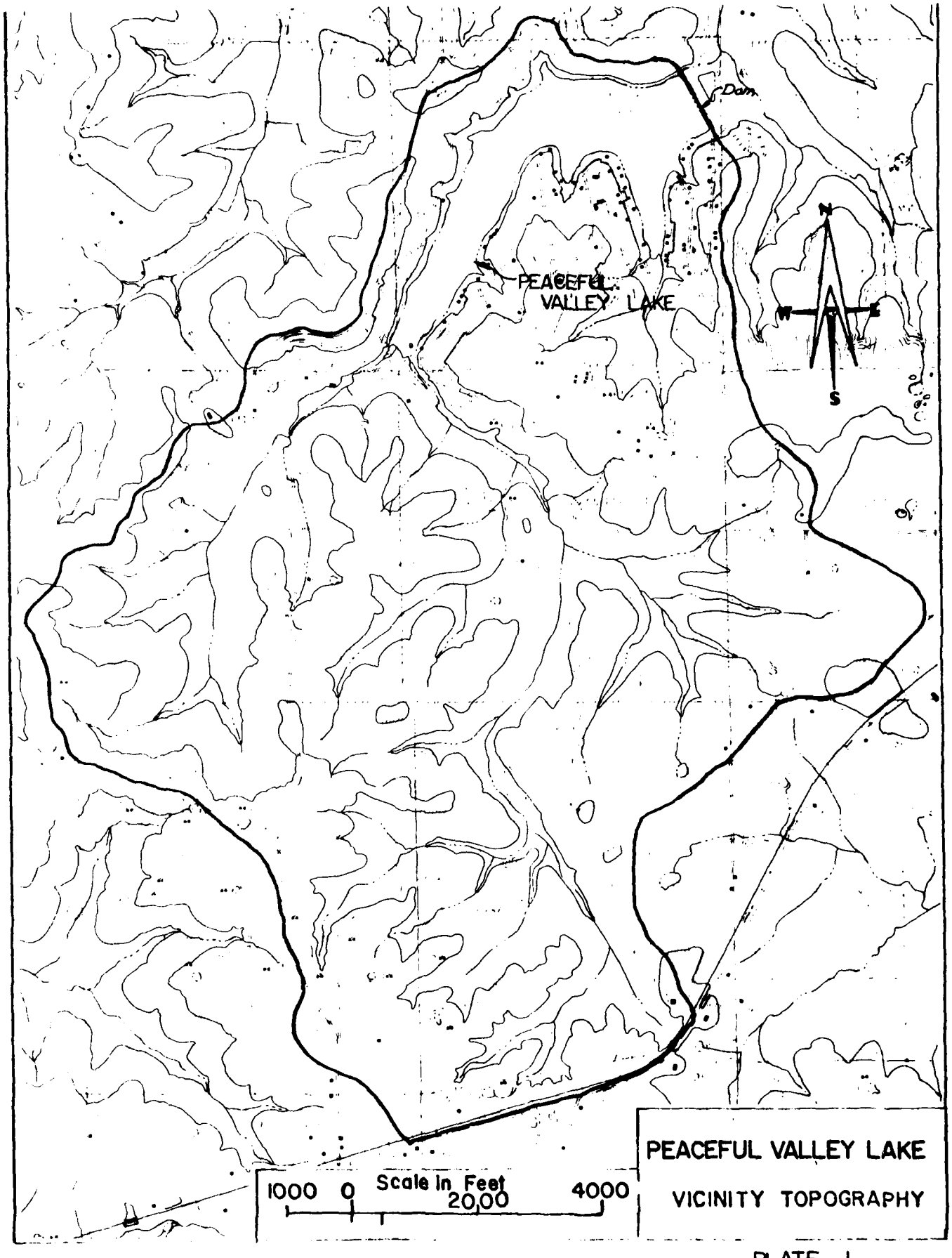
(4) Ponding of water at the toe between the embankment and the sewage lagoon should be eliminated.

(5) Up-to-date records of all future maintenance and repairs should be kept.

(6) Rip rap on the upstream face of the embankment should be continued to the crest.

(7) Spillway capacity and/or height of dam should be increased to pass 100 percent (100%) of the Probable Maximum Flood, however, caution must be exercised in increasing the height of the dam to prevent possible flooding of developed areas along the lake shore and upstream areas.

(8) The dam should be periodically inspected by an engineer experienced in the design and construction of dams.


Dam
PEACEFUL VALLEY LAKE
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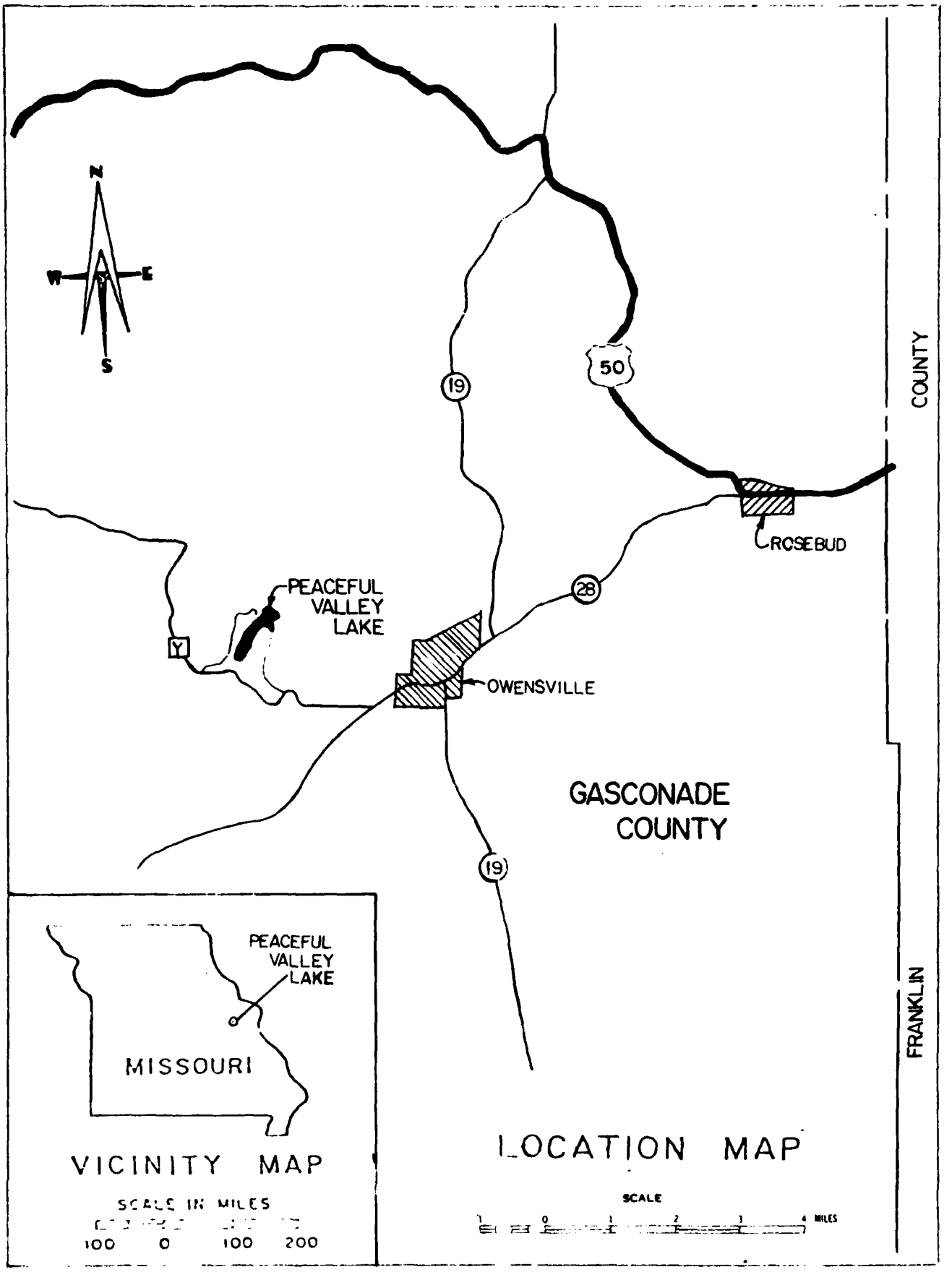
PEACEFUL VALLEY LAKE
VICINITY TOPOGRAPHY

PLATE 1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ROSEBUD
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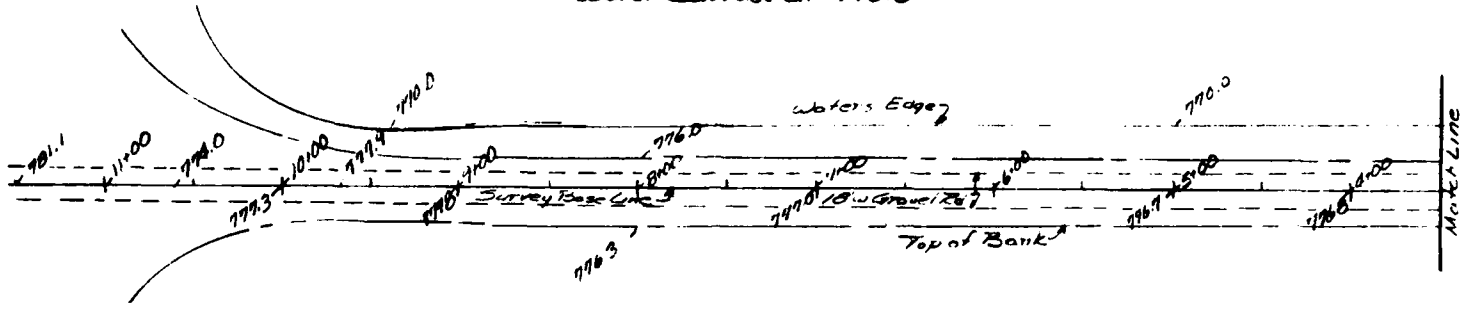
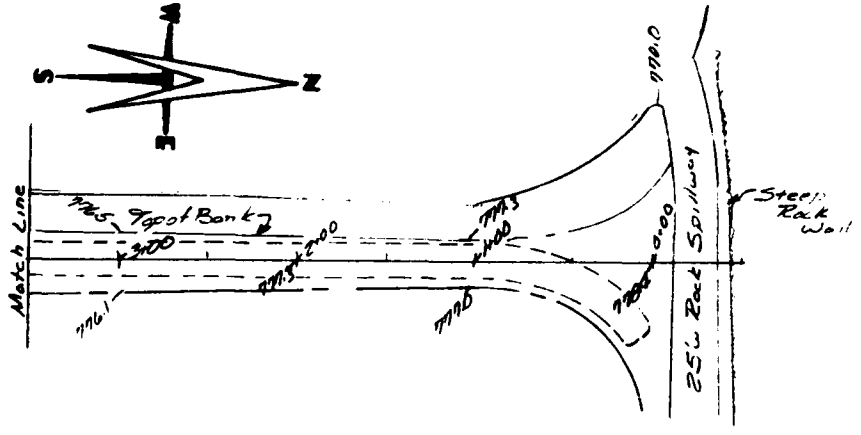
PEACEFUL
VALLEY
LAKE
Y
OWENSVILLE
GASCONADE
COUNTY
19
FRANKLIN
PEACEFUL
VALLEY
LAKE
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
LOCATION MAP
SCALE
1 0 1 2 3 4 MILES

PLATE 2

PEACEFUL VALLEY LAKE
Water Surface El. - 770.0



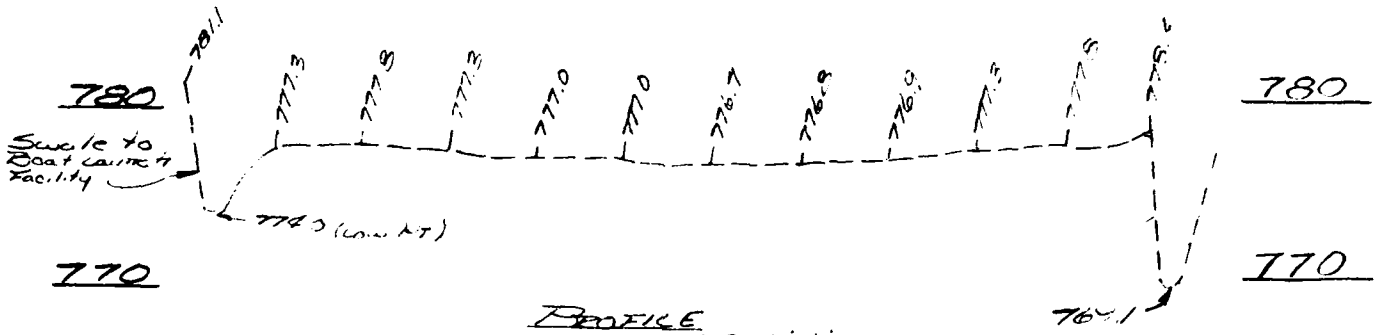
PLAN



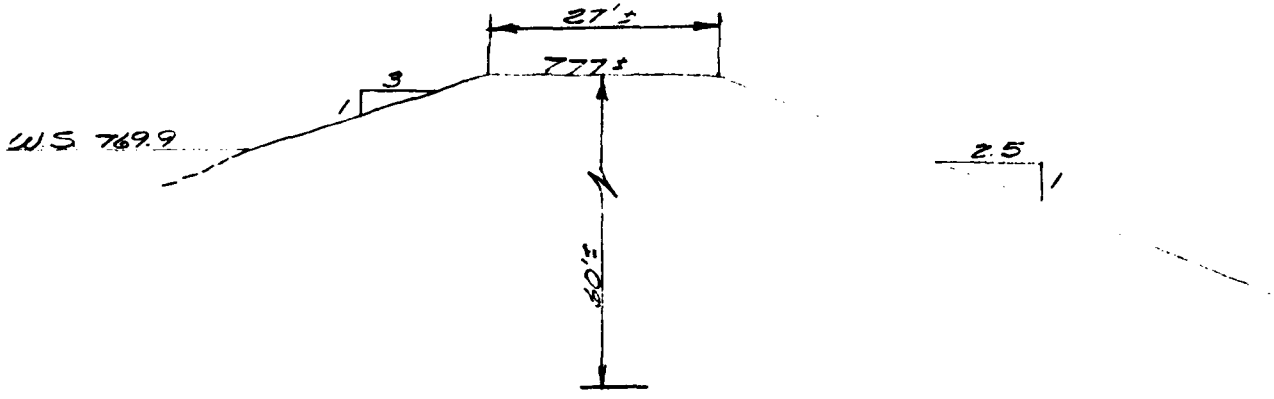
PEACEFUL VALLEY LAKE

TOP OF DAM ELEVATIONS

SCALE: 1"=100' PLATE 3



PROFILE
SCALE: 1"=200' Horiz. 1"=20' Vert.



TYPICAL CROSS SECTION
SCALE: 1"=20' Horiz. & Vert.

PEACEFUL VALLEY
DAM PROFILE
and CROSS SECTION

PLATE 4

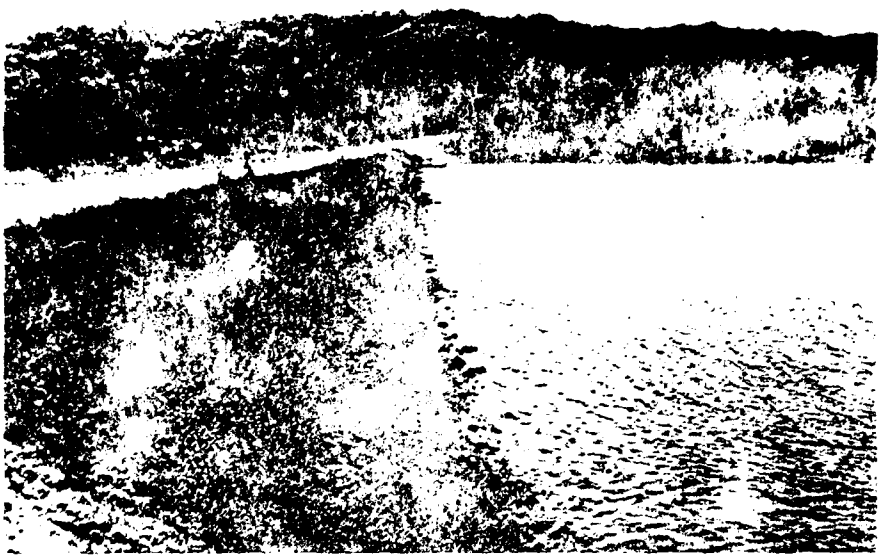


PHOTO 1 Overview of Lake and Dam

PHOTO 2 Crest of Dam

PHOTO 3 Spillway Entrance

PHOTO 4 Bedrock Showing Normal Fault in Spillway Outlet Channel

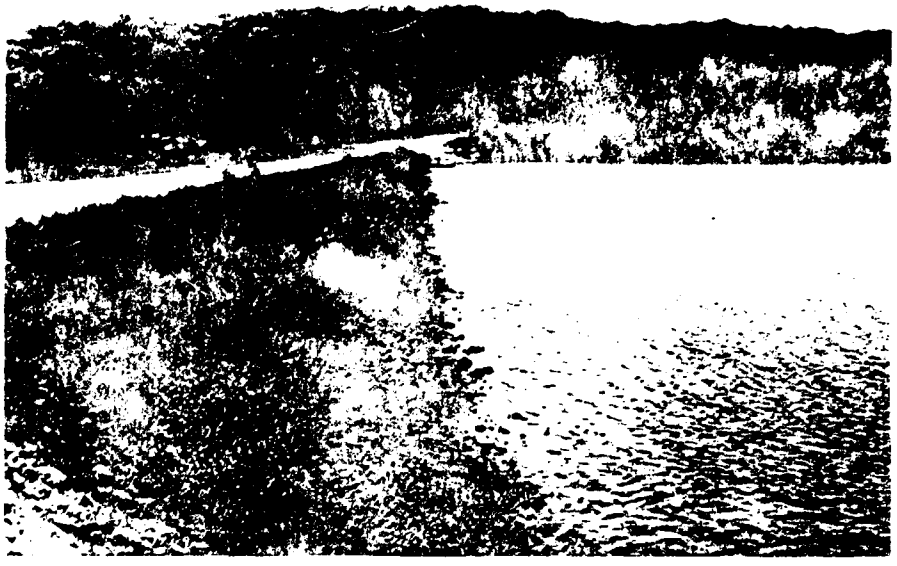


PHOTO 1 Overview of Lake and Dam

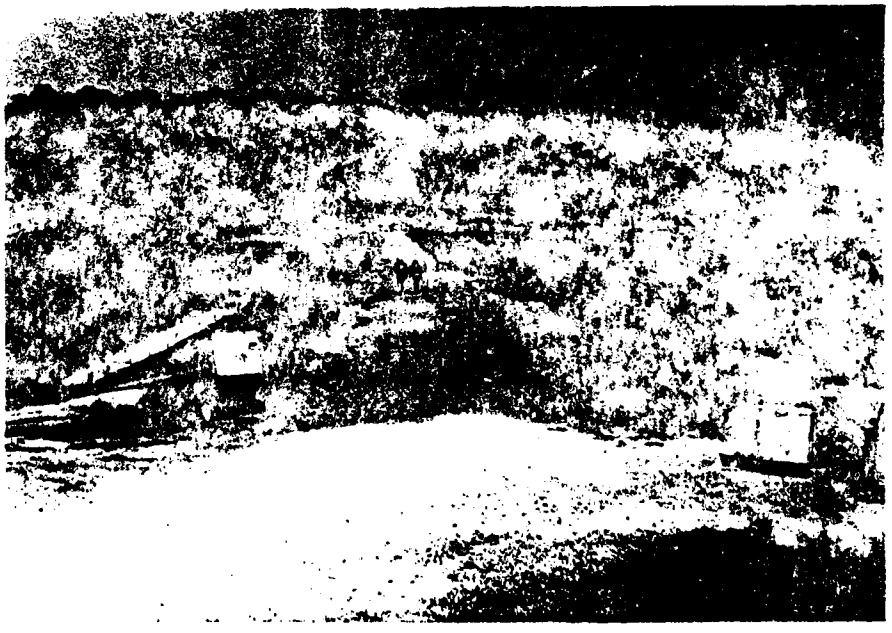


PHOTO 2 Crest of Dam

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODOLOGY

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODOLOGY

1. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 24-hour storm duration is assumed with the total rainfall depth distributed over 6-hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6-hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The nonpeak 6-hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by utilizing the Soil Conservation Service dimensionless unit hydrograph using Hydrologic Soils Groups "B" and "C", Antecedent Moisture Condition III, and SCS CN 86 used to determine rainfall excess.

Lag time was estimated using methods outlined in "Design of Small Dams", by the United States Department of The Interior, Bureau of Reclamation. Using this source, lag time is taken as 60% of the time of concentration.

Time of concentration was estimated utilizing methods outlined in the source quoted above, supplemented by data obtained during field investigation. The results of the field investigation and the computations indicated that a time of 60 minutes was appropriate. For this lake, a lag time of 0.6 hours was therefore selected.

2. The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillway, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the outlet works, spillway, and top of dam are defined by elevation-discharge curves.

3. Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

4. The above methodology has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the attached computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.

5. The inflow hydrograph was routed through the reservoir using HEC-1's Modified Puls option. Releases were calculated for: 1) the channel spillways, and, 2) the flow over the top of the dam. These releases were then combined at each of their respective elevations. The flow over the top of the dam included flow through the swale.

Flow through the spillway and outlet channel was calculated by writing the Bernoulli equation between the lake water surface and the energy gradient elevation in the channel.

With flow in the channel at normal depth, and using the lake water surface as the datum, and, assuming velocity of approach to be zero, the following equation is written:

$$\text{Stage} = \text{E.G.} + h_e$$

Where Stage H = Lake water surface (Pool Elevation)

E.G. = Energy Gradient Elevation in the channel = depth of flow + $\frac{V^2}{2g}$

h_e = Entrance loss = $k_e \frac{V^2}{2g}$

Where $k_e = 0.5$

The equation can then be simplified as follows:

$$\text{Stage} = \text{I.E.} + d_f + 1.5 \frac{V^2}{2g}$$

Where I.E. = Invert Elevation

d_f = normal flow depth for a given discharge, computed using the Manning Equation.

Stage = Pool elevation

Flow over the top of dam was calculated using the weir flow equation:

$$Q = CL(H)^{1.5}$$

where: C = Varies with head as outlined in "Handbook of Hydraulics" by Horace Williams King, revised by Ernest F. Brater.

L = Length in feet (varies with water surface)

H = Head of water in feet (varies with water surface)

Q = Discharge in cfs

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  3 AUG 78
**********
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```
    1                 A1                                                PEACEFUL VALLEY LAKE
    2                 A2                                                  NOV. 15, 1978
    3                 A3                                                MO. INV. NO.30196
    4                 B    289      -0        5      -0      -0      -0      -0      -0      -4      -0
    5                 B1     5
    6                 J      1       6        1
    7                 J1   .05     .10      .15     .20     .50    1.00
    8                 K      0  INFLOW                                  3
    9                 M      1       2     5.24                       1                               1
   10                 P             26      100     120     130
   11                 I                                                      -1      -86              .05
   12                 W2            0.6
   13                 X  10.4H     -.1        3
   14                 K      1 ROUTING                          2       2
   15                 Y                                1       1
   16                 Y1     1                                                -770.00      -1
   17                 Y4 770.0   771.0   772.0   773.0   774.0   775.0   776.0   777.0   778.0   779.0
   18                 Y4 780.0   781.0
   19                 Y5     0    61.8   182.4   352.2   567.4   885.3  1380.4  2070.6  5004.1 10496.9
   20                 Y5 17779 26467.3
   21                 $S     0   175.0   354.4   538.6   727.0   920.0  1117.4  1319.4  1525.8  1736.6
   22                 $S1952.0  2172.5
   23                 $E 770.0   771.0   772.0   773.0   774.0   775.0   776.0   777.0   778.0   779.0
   24                 $E 780.0   781.0
   25                 $$ 770.0
   26                 ED 774.0
   27                 K     99
```

COMPUTER INPUT DATA

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 3 AUG 78
****

RUN DATE= 11/16/78.
TIME= 16.30.43.

PEACEFUL VALLEY LAKE
NOV. 15, 1978
40. INV. NO.30196

JOB SPECIFICATION

NI	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	-0	5	-0	-0	-0	-0	-0	-4	-0
			JOPER	NWT	LROPT	TRACE			
			5	-0	-0	-0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1
RTIOS= .05 .10 .15 .20 .50 1.00

****

SUB-AREA RUNOFF COMPUTATION

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
INFLOW		0	-0	-0	-0	3	-0	-0	-0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	5.24	-0.00	5.24	1.00	-0.000	-0	1	-0

PRECIP DATA

SPFE	P6S	R6	R12	R24	R48	R72	R96
-0.00	26.00	100.00	120.00	130.00	-0.00	-0.00	-0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
-0	-0.00	-0.00	1.00	-0.00	-0.00	1.00	-1.00	-86.00	-0.00	.05

CURVE NO = -86.00 WETNESS = -1.00 EFFECT CN = 86.00

UNIT HYDROGRAPH DATA
TC= -0.00 LAG= .60

RECESSION DATA
STRTQ= 10.48 QRCSN= -.10 RTIOR= 3.00

UNIT HYDROGRAPH 36 END OF PERIOD ORDINATES, TC= -0.00 HOURS, LAG= .60 VOL= 1.00

201.	607.	1174.	2000.	2916.	3579.	3910.	3930.	3743.	3397.
2965.	2486.	1851.	1496.	1207.	993.	807.	654.	527.	424.
347.	279.	223.	182.	148.	119.	98.	79.	63.	52.
42.	36.	30.	24.	18.	13.	8.	3.		

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

INPUT UNIT HYDROGRAPH

1.01	.10	2	.01	.00	.01	9.	1.01	12.10	146	.22	.21	.01	2889.
1.01	.15	3	.01	.00	.01	9.	1.01	12.15	147	.22	.21	.01	3055.
1.01	.20	4	.01	.00	.01	10.	1.01	12.20	148	.22	.21	.01	3335.
1.01	.25	5	.01	.00	.01	11.	1.01	12.25	149	.22	.21	.01	3743.
1.01	.30	6	.01	.00	.01	13.	1.01	12.30	150	.22	.21	.01	4244.
1.01	.35	7	.01	.00	.01	15.	1.01	12.35	151	.22	.21	.01	4792.
1.01	.40	8	.01	.00	.01	18.	1.01	12.40	152	.22	.21	.01	5343.
1.01	.45	9	.01	.00	.01	20.	1.01	12.45	153	.22	.21	.01	5870.
1.01	.50	10	.01	.00	.01	22.	1.01	12.50	154	.22	.21	.01	6351.
1.01	.55	11	.01	.00	.01	24.	1.01	12.55	155	.22	.21	.01	6772.
1.01	1.00	12	.01	.00	.01	25.	1.01	13.00	156	.22	.21	.01	7116.
1.01	1.05	13	.01	.00	.01	26.	1.01	13.05	157	.26	.25	.01	7394.
1.01	1.10	14	.01	.00	.01	27.	1.01	13.10	158	.26	.25	.01	7639.
1.01	1.15	15	.01	.00	.01	28.	1.01	13.15	159	.26	.25	.01	7868.
1.01	1.20	16	.01	.00	.01	28.	1.01	13.20	160	.26	.25	.01	8101.
1.01	1.25	17	.01	.00	.01	28.	1.01	13.25	161	.26	.25	.01	8348.
1.01	1.30	18	.01	.00	.01	29.	1.01	13.30	162	.26	.26	.00	8601.
1.01	1.35	19	.01	.00	.01	29.	1.01	13.35	163	.26	.26	.00	8851.
1.01	1.40	20	.01	.00	.01	29.	1.01	13.40	164	.26	.26	.00	9087.
1.01	1.45	21	.01	.00	.01	29.	1.01	13.45	165	.26	.26	.00	9304.
1.01	1.50	22	.01	.00	.01	29.	1.01	13.50	166	.26	.26	.00	9497.
1.01	1.55	23	.01	.00	.01	29.	1.01	13.55	167	.26	.26	.00	9664.
1.01	2.00	24	.01	.00	.01	30.	1.01	14.00	168	.26	.26	.00	9801.
1.01	2.05	25	.01	.00	.01	30.	1.01	14.05	169	.32	.32	.00	9923.
1.01	2.10	26	.01	.00	.01	30.	1.01	14.10	170	.32	.32	.00	10051.
1.01	2.15	27	.01	.00	.01	31.	1.01	14.15	171	.32	.32	.00	10199.
1.01	2.20	28	.01	.00	.01	33.	1.01	14.20	172	.32	.32	.00	10389.
1.01	2.25	29	.01	.00	.01	35.	1.01	14.25	173	.32	.32	.00	10627.
1.01	2.30	30	.01	.00	.01	39.	1.01	14.30	174	.32	.32	.00	10899.
1.01	2.35	31	.01	.00	.01	43.	1.01	14.35	175	.32	.32	.00	11186.
1.01	2.40	32	.01	.00	.01	48.	1.01	14.40	176	.32	.32	.00	11469.
1.01	2.45	33	.01	.00	.01	53.	1.01	14.45	177	.32	.32	.00	11735.
1.01	2.50	34	.01	.00	.01	59.	1.01	14.50	178	.32	.32	.00	11976.
1.01	2.55	35	.01	.00	.01	66.	1.01	14.55	179	.32	.32	.00	12185.
1.01	3.00	36	.01	.00	.01	73.	1.01	15.00	180	.32	.32	.00	12356.
1.01	3.05	37	.01	.00	.01	80.	1.01	15.05	181	.20	.20	.00	12464.
1.01	3.10	38	.01	.00	.01	87.	1.01	15.10	182	.40	.39	.00	12534.
1.01	3.15	39	.01	.00	.01	94.	1.01	15.15	183	.40	.39	.00	12593.
1.01	3.20	40	.01	.00	.01	102.	1.01	15.20	184	.59	.59	.00	12682.
1.01	3.25	41	.01	.00	.01	109.	1.01	15.25	185	.69	.69	.00	12905.
1.01	3.30	42	.01	.00	.01	116.	1.01	15.30	186	1.68	1.67	.01	13561.
1.01	3.35	43	.01	.00	.01	123.	1.01	15.35	187	2.77	2.75	.01	15130.
1.01	3.40	44	.01	.00	.01	130.	1.01	15.40	188	1.09	1.08	.00	17677.
1.01	3.45	45	.01	.00	.01	137.	1.01	15.45	189	.69	.69	.00	21136.
1.01	3.50	46	.01	.00	.01	144.	1.01	15.50	190	.59	.59	.00	25395.
1.01	3.55	47	.01	.01	.01	151.	1.01	15.55	191	.40	.39	.00	29632.
1.01	4.00	48	.01	.01	.01	157.	1.01	16.00	192	.40	.39	.00	32872.
1.01	4.05	49	.01	.01	.01	164.	1.01	16.05	193	.30	.30	.00	34680.
1.01	4.10	50	.01	.01	.01	170.	1.01	16.10	194	.30	.30	.00	35043.
1.01	4.15	51	.01	.01	.01	177.	1.01	16.15	195	.30	.30	.00	34211.
1.01	4.20	52	.01	.01	.01	183.	1.01	16.20	196	.30	.30	.00	32453.
1.01	4.25	53	.01	.01	.01	189.	1.01	16.25	197	.30	.30	.00	30035.
1.01	4.30	54	.01	.01	.01	195.	1.01	16.30	198	.30	.30	.00	27177.
1.01	4.35	55	.01	.01	.01	200.	1.01	16.35	199	.30	.30	.00	24427.
1.01	4.40	56	.01	.01	.01	206.	1.01	16.40	200	.30	.30	.00	22168.
1.01	4.45	57	.01	.01	.01	211.	1.01	16.45	201	.30	.30	.00	20308.
1.01	4.50	58	.01	.01	.01	217.	1.01	16.50	202	.30	.30	.00	18807.
1.01	4.55	59	.01	.01	.01	222.	1.01	16.55	203	.30	.30	.00	17570.
1.01	5.00	60	.01	.01	.01	227.	1.01	17.00	204	.30	.30	.00	16555.
1.01	5.05	61	.01	.01	.01	232.	1.01	17.05	205	.24	.24	.00	15722.
1.01	5.10	62	.01	.01	.01	237.	1.01	17.10	206	.24	.24	.00	15020.
1.01	5.15	63	.01	.01	.01	242.	1.01	17.15	207	.24	.24	.00	14414.
1.01	5.20	64	.01	.01	.01	247.	1.01	17.20	208	.24	.24	.00	13845.
1.01	5.25	65	.01	.01	.01	252.	1.01	17.25	209	.24	.24	.00	13301.

INPUT UNIT HYDROGRAPH

1.01	5.40	68	.01	.01	.01	265.	1.01	17.40	212	.24	.24	.00	11869.
1.01	5.45	69	.01	.01	.01	269.	1.01	17.45	213	.24	.24	.00	11478.
1.01	5.50	70	.01	.01	.01	273.	1.01	17.50	214	.24	.24	.00	11136.
1.01	5.55	71	.01	.01	.01	278.	1.01	17.55	215	.24	.24	.00	10846.
1.01	6.00	72	.01	.01	.01	282.	1.01	18.00	216	.24	.24	.00	10613.
1.01	6.05	73	.07	.04	.03	292.	1.01	18.05	217	.02	.02	.00	10388.
1.01	6.10	74	.07	.04	.03	316.	1.01	18.10	218	.02	.02	.00	10113.
1.01	6.15	75	.07	.04	.03	359.	1.01	18.15	219	.02	.02	.00	9734.
1.01	6.20	76	.07	.05	.03	430.	1.01	18.20	220	.02	.02	.00	9202.
1.01	6.25	77	.07	.05	.03	535.	1.01	18.25	221	.02	.02	.00	8484.
1.01	6.30	78	.07	.05	.02	665.	1.01	18.30	222	.02	.02	.00	7636.
1.01	6.35	79	.07	.05	.02	811.	1.01	18.35	223	.02	.02	.00	6727.
1.01	6.40	80	.07	.05	.02	963.	1.01	18.40	224	.02	.02	.00	5826.
1.01	6.45	81	.07	.05	.02	1115.	1.01	18.45	225	.02	.02	.00	4979.
1.01	6.50	82	.07	.05	.02	1259.	1.01	18.50	226	.02	.02	.00	4220.
1.01	6.55	83	.07	.05	.02	1394.	1.01	18.55	227	.02	.02	.00	3562.
1.01	7.00	84	.07	.05	.02	1512.	1.01	19.00	228	.02	.02	.00	3179.
1.01	7.05	85	.07	.05	.02	1614.	1.01	19.05	229	.02	.02	.00	2848.
1.01	7.10	86	.07	.06	.02	1704.	1.01	19.10	230	.02	.02	.00	2552.
1.01	7.15	87	.07	.06	.02	1785.	1.01	19.15	231	.02	.02	.00	2286.
1.01	7.20	88	.07	.06	.02	1858.	1.01	19.20	232	.02	.02	.00	2049.
1.01	7.25	89	.07	.06	.01	1923.	1.01	19.25	233	.02	.02	.00	1835.
1.01	7.30	90	.07	.06	.01	1983.	1.01	19.30	234	.02	.02	.00	1644.
1.01	7.35	91	.07	.06	.01	2036.	1.01	19.35	235	.02	.02	.00	1473.
1.01	7.40	92	.07	.06	.01	2085.	1.01	19.40	236	.02	.02	.00	1320.
1.01	7.45	93	.07	.06	.01	2129.	1.01	19.45	237	.02	.02	.00	1187.
1.01	7.50	94	.07	.06	.01	2170.	1.01	19.50	238	.02	.02	.00	1125.
1.01	7.55	95	.07	.06	.01	2208.	1.01	19.55	239	.02	.02	.00	1076.
1.01	8.00	96	.07	.06	.01	2242.	1.01	20.00	240	.02	.02	.00	1035.
1.01	8.05	97	.07	.06	.01	2274.	1.01	20.05	241	.02	.02	.00	1003.
1.01	8.10	98	.07	.06	.01	2304.	1.01	20.10	242	.02	.02	.00	977.
1.01	8.15	99	.07	.06	.01	2331.	1.01	20.15	243	.02	.02	.00	956.
1.01	8.20	100	.07	.06	.01	2357.	1.01	20.20	244	.02	.02	.00	939.
1.01	8.25	101	.07	.06	.01	2380.	1.01	20.25	245	.02	.02	.00	925.
1.01	8.30	102	.07	.06	.01	2403.	1.01	20.30	246	.02	.02	.00	914.
1.01	8.35	103	.07	.06	.01	2424.	1.01	20.35	247	.02	.02	.00	905.
1.01	8.40	104	.07	.06	.01	2443.	1.01	20.40	248	.02	.02	.00	897.
1.01	8.45	105	.07	.06	.01	2462.	1.01	20.45	249	.02	.02	.00	891.
1.01	8.50	106	.07	.06	.01	2479.	1.01	20.50	250	.02	.02	.00	886.
1.01	8.55	107	.07	.06	.01	2496.	1.01	20.55	251	.02	.02	.00	882.
1.01	9.00	108	.07	.06	.01	2511.	1.01	21.00	252	.02	.02	.00	879.
1.01	9.05	109	.07	.06	.01	2525.	1.01	21.05	253	.02	.02	.00	877.
1.01	9.10	110	.07	.07	.01	2539.	1.01	21.10	254	.02	.02	.00	877.
1.01	9.15	111	.07	.07	.01	2552.	1.01	21.15	255	.02	.02	.00	877.
1.01	9.20	112	.07	.07	.01	2564.	1.01	21.20	256	.02	.02	.00	877.
1.01	9.25	113	.07	.07	.01	2576.	1.01	21.25	257	.02	.02	.00	877.
1.01	9.30	114	.07	.07	.01	2587.	1.01	21.30	258	.02	.02	.00	877.
1.01	9.35	115	.07	.07	.01	2597.	1.01	21.35	259	.02	.02	.00	877.
1.01	9.40	116	.07	.07	.01	2607.	1.01	21.40	260	.02	.02	.00	877.
1.01	9.45	117	.07	.07	.01	2617.	1.01	21.45	261	.02	.02	.00	877.
1.01	9.50	118	.07	.07	.01	2626.	1.01	21.50	262	.02	.02	.00	877.
1.01	9.55	119	.07	.07	.01	2635.	1.01	21.55	263	.02	.02	.00	877.
1.01	10.00	120	.07	.07	.01	2643.	1.01	22.00	264	.02	.02	.00	877.
1.01	10.05	121	.07	.07	.01	2651.	1.01	22.05	265	.02	.02	.00	877.
1.01	10.10	122	.07	.07	.01	2659.	1.01	22.10	266	.02	.02	.00	877.
1.01	10.15	123	.07	.07	.01	2666.	1.01	22.15	267	.02	.02	.00	877.
1.01	10.20	124	.07	.07	.00	2674.	1.01	22.20	268	.02	.02	.00	877.
1.01	10.25	125	.07	.07	.00	2680.	1.01	22.25	269	.02	.02	.00	877.
1.01	10.30	126	.07	.07	.00	2687.	1.01	22.30	270	.02	.02	.00	877.
1.01	10.35	127	.07	.07	.00	2693.	1.01	22.35	271	.02	.02	.00	877.
1.01	10.40	128	.07	.07	.00	2699.	1.01	22.40	272	.02	.02	.00	877.
1.01	10.45	129	.07	.07	.00	2705.	1.01	22.45	273	.02	.02	.00	877.
1.01	10.50	130	.07	.07	.00	2711.	1.01	22.50	274	.02	.02	.00	877.
1.01	10.55	131	.07	.07	.00	2716.	1.01	22.55	275	.02	.02	.00	877.

INPUT UNIT HYDROGRAPH

1.01	11.05	137	.07	.07	.00	2726.	1.01	23.05	277	.02	.02	.00	877.
1.01	11.10	134	.07	.07	.00	2731.	1.01	23.10	278	.02	.02	.00	877.
1.01	11.15	135	.07	.07	.00	2736.	1.01	23.15	279	.02	.02	.00	877.
1.01	11.20	136	.07	.07	.00	2740.	1.01	23.20	280	.02	.02	.00	877.
1.01	11.25	137	.07	.07	.00	2744.	1.01	23.25	281	.02	.02	.00	877.
1.01	11.30	138	.07	.07	.00	2749.	1.01	23.30	282	.02	.02	.00	877.
1.01	11.35	139	.07	.07	.00	2753.	1.01	23.35	283	.02	.02	.00	877.
1.01	11.40	140	.07	.07	.00	2757.	1.01	23.40	284	.02	.02	.00	877.
1.01	11.45	141	.07	.07	.00	2760.	1.01	23.45	285	.02	.02	.00	877.
1.01	11.50	142	.07	.07	.00	2764.	1.01	23.50	286	.02	.02	.00	877.
1.01	11.55	143	.07	.07	.00	2767.	1.01	23.55	287	.02	.02	.00	877.
1.01	12.00	144	.07	.07	.00	2771.	1.02	0.00	288	.02	.02	.00	877.
									SUM	33.80	32.02	1.78	1292460.
										(859.)	(813.)	(45.)	(36598.39)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	35043.	14118.	4486.	4486.	1292013.
CMS	992.	400.	127.	127.	36586.
INCHES		25.06	31.86	31.86	31.86
MM		636.60	809.15	809.15	809.15
AC-FT		7001.	8898.	8898.	8898.
THOUS CU M		8635.	10976.	10976.	10976.

HYDROGRAPH AT STAINFLOW FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1752.	706.	224.	224.	64601.
CMS	50.	20.	6.	6.	1829.
INCHES		1.25	1.59	1.59	1.59
MM		31.83	40.46	40.46	40.46
AC-FT		350.	445.	445.	445.
THOUS CU M		432.	549.	549.	549.

HYDROGRAPH AT STAINFLOW FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3504.	1412.	449.	449.	129201.
CMS	99.	40.	13.	13.	3659.
INCHES		2.51	3.19	3.19	3.19
MM		63.66	80.91	80.91	80.91
AC-FT		700.	890.	890.	890.
THOUS CU M		864.	1098.	1098.	1098.

HYDROGRAPH AT STAINFLOW FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5256.	2118.	673.	673.	193802.
CMS	149.	60.	19.	19.	5488.
INCHES		3.76	4.78	4.78	4.78
MM		95.49	121.37	121.37	121.37
AC-FT		1050.	1335.	1335.	1335.
THOUS CU M		1295.	1646.	1646.	1646.

HYDROGRAPH AT STAINFLOW FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME

INPUT UNIT HYDROGRAPH

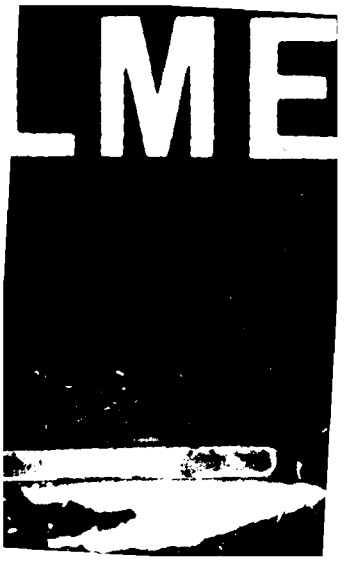
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	770.00	770.00	774.00
STORAGE	0.	0.	727.
OUTFLOW	0.	0.	567.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	772.06	0.00	366.	193.	0.00	18.92	0.00
.10	773.84	0.00	696.	532.	0.00	18.75	0.00
.15	775.36	1.36	991.	1063.	7.75	18.58	0.00
.20	776.60	2.60	1238.	1792.	8.25	18.33	0.00
.50	779.48	5.48	1841.	14015.	10.83	16.50	0.00
1.00	781.45	7.45	2271.	30037.	13.50	16.42	0.00

COMPUTER SUMMARY ANALYSIS


LME